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A MUFFLER FOR AN APPARATUS FOR SUPPLYING BREATHABLE GAS

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(57) Claim

1. A muffler suitable for use with an apparatus for supplying breathable gas to a patient, wherein said muffler is sized and shaped to be located internal the housing of the apparatus.

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PATENTS ACT 1990

COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title: A Muffler for an Apparatus for Supplying Breathable Gas

ASSOCIATED PROVISIONAL APPLICATION DETAILS

[31] Application No(s)	[33] Country	[32] Application Date
PP0151	AU	3 November 1997

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

A MUFFLER FOR AN APPARATUS FOR SUPPLYING BREATHABLE GAS

FIELD OF THE INVENTION

The present invention relates to a muffler for use with an apparatus for supplying breathable gas.

The invention has been developed primarily for use with a breathable gas supply apparatus used in, for example, Continuous Positive Airway Pressure (CPAP) treatment of Obstructive Sleep Apnea (OSA) and similar sleep disordered breathing conditions. The invention also finds application in breathable gas delivery systems used for assisted ventilation or mechanical respiration.

BACKGROUND OF THE INVENTION

The pressurized gas supplied in CPAP treatment of OSA serves to pneumatically splint open the patient's airways. The pressure of the supplied gas may be constant, bi-level (in synchronism with patient breathing) or auto-setting in level. Throughout this specification any reference to CPAP is intended to incorporate a reference to any one of, or combinations of, these forms of breathable gas supply.

CPAP treatment is generally administered whilst the patient and any bed partner are sleeping. As the gas supply apparatus is normally located within a few metres of the patient it is desirable to minimise the noise produced by the gas supply apparatus so as to minimize sleep disturbance.

CPAP breathable gas supply apparatus generally comprise a plastic housing or casing having a gas flow generator and an electrical control and power system therein. A flexible conduit connects the outlet of the apparatus to a nose and/or mouth mask worn by the patient so as to communicate the supplied gas to the patient's airways.

The flow generator assembly usually consists of a brushless electric motor driving a fan or turbine. The noise produced by the flow generator assembly has three basic transmission paths to surrounding atmosphere. It is radiated from the apparatus housing, transmitted from the turbine outlet to be propagated along the conduit that connects the outlet of the apparatus to the patient mask and transmitted from the turbine inlet to be propagated along the gas inlet path (in the opposite direction to the gas flow) to the housing gas inlet and so to atmosphere.

It is known to place a humidifier in the flow path between the patient and the flow generator to moisten the generally cool dry supplied air and thereby increase patient comfort.

Directing the supplied gas through a humidifier has been found also to reduce the noise transmitted down the patient gas supply conduit. Hitherto, patients complaining of conduit-transmitted noise have been advised to place an humidifier between the apparatus outlet and mask. However, this known arrangement has several

disadvantages. In particular, the use of an extra external component adds cost, is susceptible to misconnection, is inconvenient and is unsightly. Further, there are instances where it is inappropriate to introduce a humidifier, such as in a humid climate.

Another noise reducing approach is used in the applicant's bi-level CPAP apparatus model VPAPII. The VPAPII includes a sound enclosure within the apparatus housing having an outlet chamber mounted therein. The metal sound enclosure has a first and second chamber, each having a port to allow the passage of air into the first chamber through to, and then out of, the second chamber. The flow generator assembly and the outlet chamber are located in the second chamber. Air is drawn past a baffle and into the first chamber which includes a step-like labyrinth baffle allowing the free flow of air through the first chamber into the second chamber whilst attenuating the noise from the flow generator assembly propagating along the air inlet path. The internal surfaces of the sound enclosure are lined with sound absorbing skinned polyurethane foam.

In one version of VPAPII, the flow generator assembly is mounted within the sound enclosure and attached to the outlet chamber by a rigid metal mounting bracket. In another earlier version, the flow generator assembly sat on one inner face of the second chamber and was cushioned by EVA foam that was in turn adhered to the second chamber inner face. In both versions, the blower air path outlet is secured to the inlet port of the outlet chamber by way of a silicone rubber conduit.

The outlet chamber is formed as one substantially rectangular chamber moulded from "ignition resistant" ABS. Foam is adhered to the outlet chamber's internal surfaces but otherwise the outlet chamber is 'empty' in that it has no labyrinthine or tortuous path.

The VPAPII requires expensive materials to produce, is complex in both manufacture and assembly and does not allow for rapid reassembly after servicing. It also utilises steel components which are relatively heavy and affect the portability of the apparatus.

It is an object of the present invention to substantially overcome or at least ameliorate one or more of the deficiencies of the prior art.

SUMMARY OF THE INVENTION

Accordingly, in a first aspect, the present invention discloses a muffler suitable for use with an apparatus for supplying breathable gas to a patient, wherein said muffler is sized and shaped to be located internal the housing of the apparatus.

In a second aspect, the present invention discloses an apparatus for supplying breathable gas to a patient, wherein said apparatus includes a muffler internal the

apparatus housing, the muffler including means to locate one or more acoustically absorptive inserts within the muffler.

In a third aspect, the present invention discloses an apparatus for supplying breathable gas to a patient, the apparatus including a flow generator, a gas outlet and a muffler interposed in fluid communication between the flow generator and the outlet, the muffler including means to locate one or more acoustically absorptive inserts within the muffler.

The muffler preferably includes an expansion chamber having an inlet, an outlet and at least one internal baffle in the flow path therebetween. The expansion chamber reduces the velocity of the supplied gas and the baffle directs the flow to reflect and diffuse noise. By reducing the flow velocity before diverting the flow direction, pressure losses are minimized.

The muffler preferably also includes one or more internal acoustically absorptive foam inserts. The foam inserts also permit the effective internal volume of the muffler to be varied.

In a preferred embodiment, the insert(s) include recesses or holes and the muffler locating means are in the form one or more internal support posts adapted to be received within the recesses to locate the insert(s).

The breathable gas supply apparatus preferably also includes a flow sensor, a humidifier connection device and a pressure transducer interposed between the muffler outlet and the apparatus outlet.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described, by way of examples only, with reference to the accompanying drawings in which:

Fig. 1 is a sectional plan view of a breathable gas supply apparatus housing and a first embodiment of a muffler according to the invention;

Fig. 2 is a top plan view of the lower half of the muffler shown in Fig. 1;

Fig. 3 is a bottom plan view of the top half of the muffler shown in Fig. 1;

Fig. 4 is perspective view of the muffler shown in Fig. 1;

Fig. 5 is a schematic view of a breathable gas supply circuit; and

Fig. 6 is a schematic view of a breathable gas supply circuit similar to Fig. 1 but including a humidifier;

Fig. 7 is a perspective view of a second embodiment of a muffler according to the invention;

Fig. 8 is a perspective view of the muffler shown in Fig. 7 rotated through 90°;

Fig. 9 is a cross-sectional side view of a third embodiment of a muffler according to the invention;

Fig. 10 is a perspective view of the muffler shown in Fig. 9;

Fig. 11 is a perspective view of the muffler shown in Fig. 7;

Fig. 12 is an upper perspective view of the lower half of the muffler shown in Fig. 7;

Fig 13 is a top plan view of the lower half of the muffler shown in Fig. 7; and

Fig. 14 is a bottom plan view of the top half of the muffler shown in Fig. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows a sectional plan view of the lower half of a casing 10 of a breathable gas supply apparatus 12 used, for example, to administer CPAP treatment. In accordance with a first embodiment of the invention, a muffler 14 is provided internal the casing 10. The muffler 14 includes an inlet, in the form circular aperture 16, and an outlet, in the form of circular aperture 18. The flow path of the gas from the flow generator (not shown) of the apparatus 12 is generally indicated by dashed line 20.

The muffler 14 also includes a baffle 21 and a plurality of upright support posts 22 about which are located foam inserts 24 having complimentary holes 25. The inserts 24 are preferably formed from an acoustically absorptive polyurethane foam having a high NRC absorption coefficient, for example 0.6 or greater, and a high flow resistivity of, for example of 30 KRAYLS/m or greater, such as DECI-FOAM type manufactured by INC CORPORATION, USA. The foam inserts can also be corrugated or otherwise have an irregular, textured or rough surface to attenuate noise by promoting internal reflections and the like. Whilst two form inserts 24 are shown in the preferred embodiment it will be appreciated that more or less can be used, depending on the application.

As best shown in Figures 2 to 4, the muffler 14 is formed from a lower muffler casing half 26 and an upper casing half 28 which interconnect with each other along external locating flange 30. Both the muffler halves are injection moulded from plastics material.

The external shape of the muffler 14 is determined by several factors. Firstly, the muffler 14 is sized to have an internal cavity of sufficient predetermined volume so as to act as an expansion chamber and slow the supplied gas flow. Also, the muffler 14 is shaped and sized so as to be able to include the foam inserts 24 and one or more of the baffles 20 therein. The muffler 14 must also be shaped so as to fit within the casing 10 of the breathable gas supply apparatus 12. In this regard, the preferred embodiment shown in the drawings includes bight regions 32 which allow joining posts 34 to extend between the top and bottom halves of the apparatus casing 10 to allow connection thereof. Further, the muffler 14 includes corner portions 36 which are shaped to

approximate the adjacent external corners 38 of the apparatus casing 12 so as to maximise efficient usage of available casing volume.

The flow generator of the apparatus 12 usually comprises a brushless electric motor driving a fan or turbine which, in the embodiment shown, is located in the general area denoted 40. The muffler 14 includes a recessed region 42 so as to position the inlet 16 nearby the outlet of the flow generator. The outlet 18 is positioned so as to be located nearby the inlet, if applicable, of a flow sensor (not shown).

The muffler 14 is believed to reduce the noise generated by the flow generator by one or more of the methods described below.

Firstly, the muffler 14 acts as an expansion chamber to reduce the gas supply velocity which allows the gas to flow along the tortuous path without causing excessive pressure loss. The tortuous flow path followed by the slowed gas reduces the higher frequency noise components of the noise in a known manner. The flow path also causes the higher frequency noise to be internally reflected into the muffler 14 interior, and not towards the patient.

Secondly, the foam inserts 24 act as partial acoustic absorbers.

In testing of the first embodiment described above, an L_{eq} of 55 dBA was recorded at a pressure of 20 cmH_2O at the patient mask. With the muffler 14 removed and the flexible conduit connected directly to the outlet of the flow generator a level of 75 dBA was recorded, thereby highlighting the noise reduction advantages. A 20 dBA reduction corresponds to a temporal appreciation of "much quieter".

Referring now to Fig. 5 there is shown a schematic diagram of a breathable gas supply apparatus 12 whose breathable gas supply circuit comprises a flow generator 44, the muffler 14, volumetric flow sensor 46, humidifier connector 48, pressure transducer 50, flexible conduit 52, and patient mask 54. By providing the muffler 14 internal the casing 10, it is possible to locate it immediately downstream of the flow generator 44 and upstream of the volumetric flow sensor 46, humidifier connector 48 and pressure transducer 50. Accordingly, any impedance to the gas supply flow caused by the muffler 14 will already have taken place before the gas reaches these measuring devices and therefore will not affect any control signals or the like generated by or from these devices that are used to control the volume or pressure of the gas supplied to a patient. This remains the case even when a humidifier 56 is incorporated into the gas supply circuit, as shown in Fig. 6.

Figs. 7 and 8 show a second embodiment of a muffler 58 according to the invention which is described using like reference numerals to the first embodiment. The muffler 58 is positioned adjacent a foam mounting block 60 used to support and locate motor 62 and turbine 64. The complementary shaping of the block wall 66 and adjacent muffler wall 68 maximises the usage of internal space within the apparatus

housing and also allows the outlet 70 of the turbine 64 to be directly connected by coupling device 71 to the inlet 16 of the muffler 58.

Figs. 9 and 10 show a muffler 80 according to a third embodiment of the invention. The muffler 80 is generally in the shape of a hollow cylinder and has a first cylindrical recess 82 which serves as a gas inlet port. A second cylindrical recess 84 receives a motor 86 which drives an impeller 88 having a central inlet (now shown). The muffler 80 also includes an annular passageway 90 between the periphery of the impeller and the interior 92 of the muffler. An outlet pipe 94 communicates air from the muffler interior 92.

As indicated by arrows 96, gas is drawn through the recess 82 into the impeller 88 and then expelled radially from the impeller 88 through the annular passageway 90 into the muffler interior 92 and so to the muffler outlet pipe 94.

Figs. 11 to 14 show further views of the muffler 58 according to the second embodiment of the invention. In this embodiment, the inlet 16 and the outlet 18 are both located on the upper casing half 28. Fig. 12 shows the muffler 58 with four of the inserts 24 located about the support posts 22.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

The claims defining the invention are as follows:

1. A muffler suitable for use with an apparatus for supplying breathable gas to a patient, wherein said muffler is sized and shaped to be located internal the housing of the apparatus.

2. A muffler as claimed in claim 1, wherein the muffler includes an expansion chamber having an inlet, an outlet and at least one internal baffle in the flow path therebetween.

3. A muffler as claimed in claim 1 or 2, wherein the muffler includes one or more internal acoustically absorptive foam inserts.

4. A muffler as claimed in claim 3, wherein the muffler includes means to locate said one or more acoustically absorptive foam inserts within the muffler.

5. A muffler as claimed in claim 1, wherein the insert(s) include recesses or holes and the insert locating means comprise one or more internal support posts adapted to be received within the recesses or holes to thereby locate the insert(s).

6. A muffler as claimed in claim 3, 4 or 5, wherein the foam inserts are produced from an acoustically absorptive polyurethane foam.

7. A muffler as claimed in claim 6, wherein the polyurethane foam has a NRL absorption coefficient of at least 6 and a flow resistivity of at least 30 KRAYLS/m.

8. A muffler as claimed in claim 6 or 7, wherein the polyurethane foam is DECI-FOAM type manufactured by INC CORPORATION.

9. An apparatus for supplying breathable gas to a patient, wherein said apparatus includes a muffler internal the apparatus housing, the muffler including means to locate one or more acoustically absorptive inserts within the muffler.

10. An apparatus for supplying breathable gas to a patient, the apparatus including a flow generator, a gas outlet and a muffler interposed in fluid communication between the flow generator and the outlet, the muffler including means to locate one or more acoustically absorptive inserts within the muffler.

11. An apparatus as claimed in claim 9 or 10, wherein the breathable gas supply apparatus also includes a flow sensor, a humidifier connection device and a pressure transducer interposed between the muffler outlet and the apparatus outlet.

12. An apparatus for supplying breathable gas to a patient, said apparatus includes the muffler claimed in any one of claims 1 to 8.

13. A muffler substantially as described herein with reference to Figs. 1 to 6, Figs. 7 and 8 and 11 to 14 or Figs. 9 and 10 of the accompanying drawings.

14. An apparatus for supplying breathable gas to a patient, said apparatus substantially as described herein with reference to Figs. 1 to 6, Figs. 7 and 8 and 11 to 14 or Figs. 9 and 10 of the accompanying drawings.

DATED this Third Day of November 1998

ResMed Limited

Patent Attorneys for the Applicant/Nominated Person

SPRUSON & FERGUSON

A MUFFLER FOR AN APPARATUS FOR SUPPLYING BREATHABLE GAS

Abstract

A muffler (14) suitable for use with an apparatus (12) for supplying breathable gas to a patient, the muffler (14) being sized and shaped to be able to be located internal the housing (10) of the apparatus (12).

The muffler (14) can include means to locate one or more acoustically absorptive inserts (24) within the muffler (14).

The apparatus (12) can include a flow generator, a gas outlet (18) and the muffler (14) can be interposed in fluid communication between the flow generator and the outlet (18).

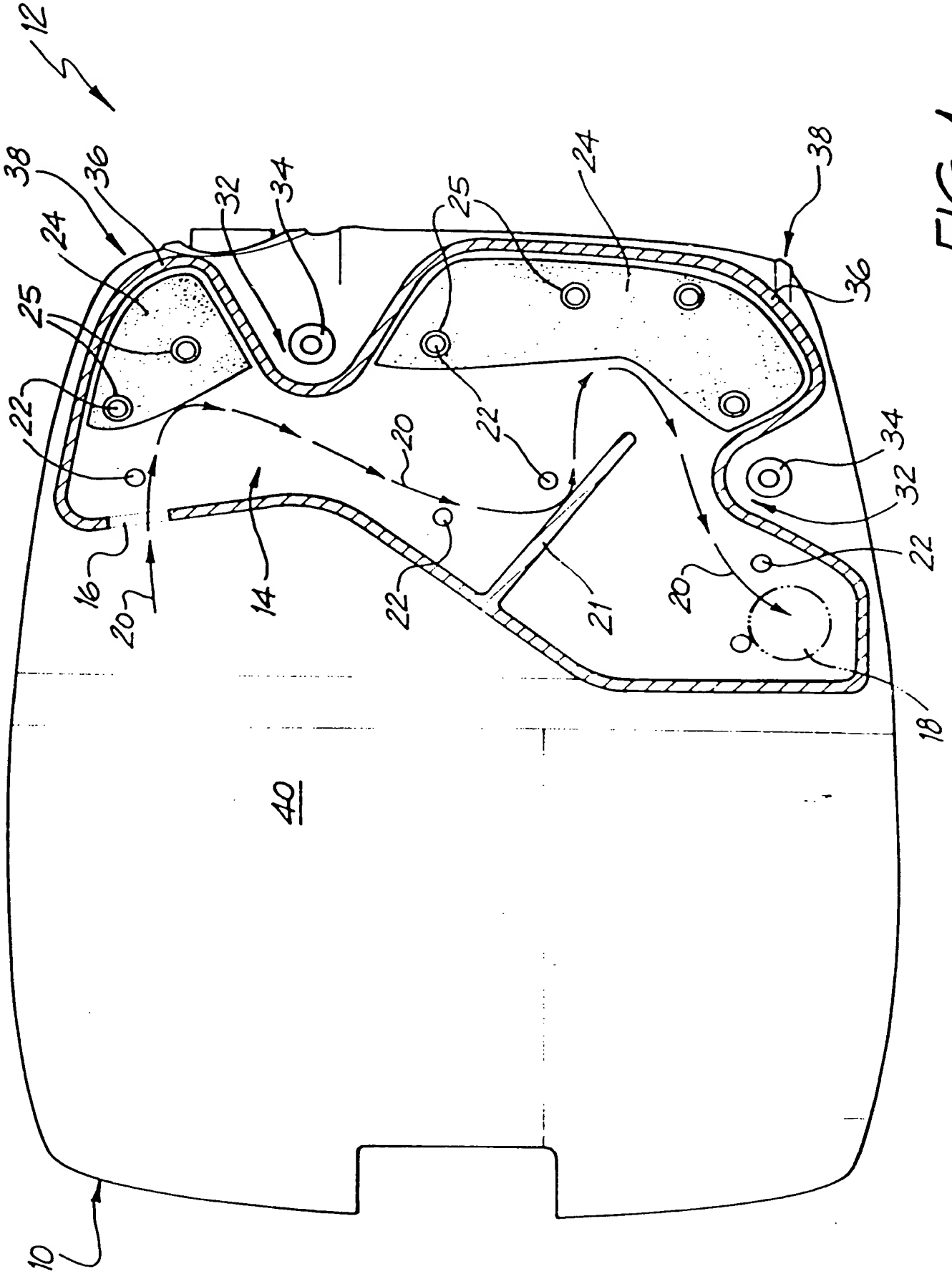
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FIG. 1

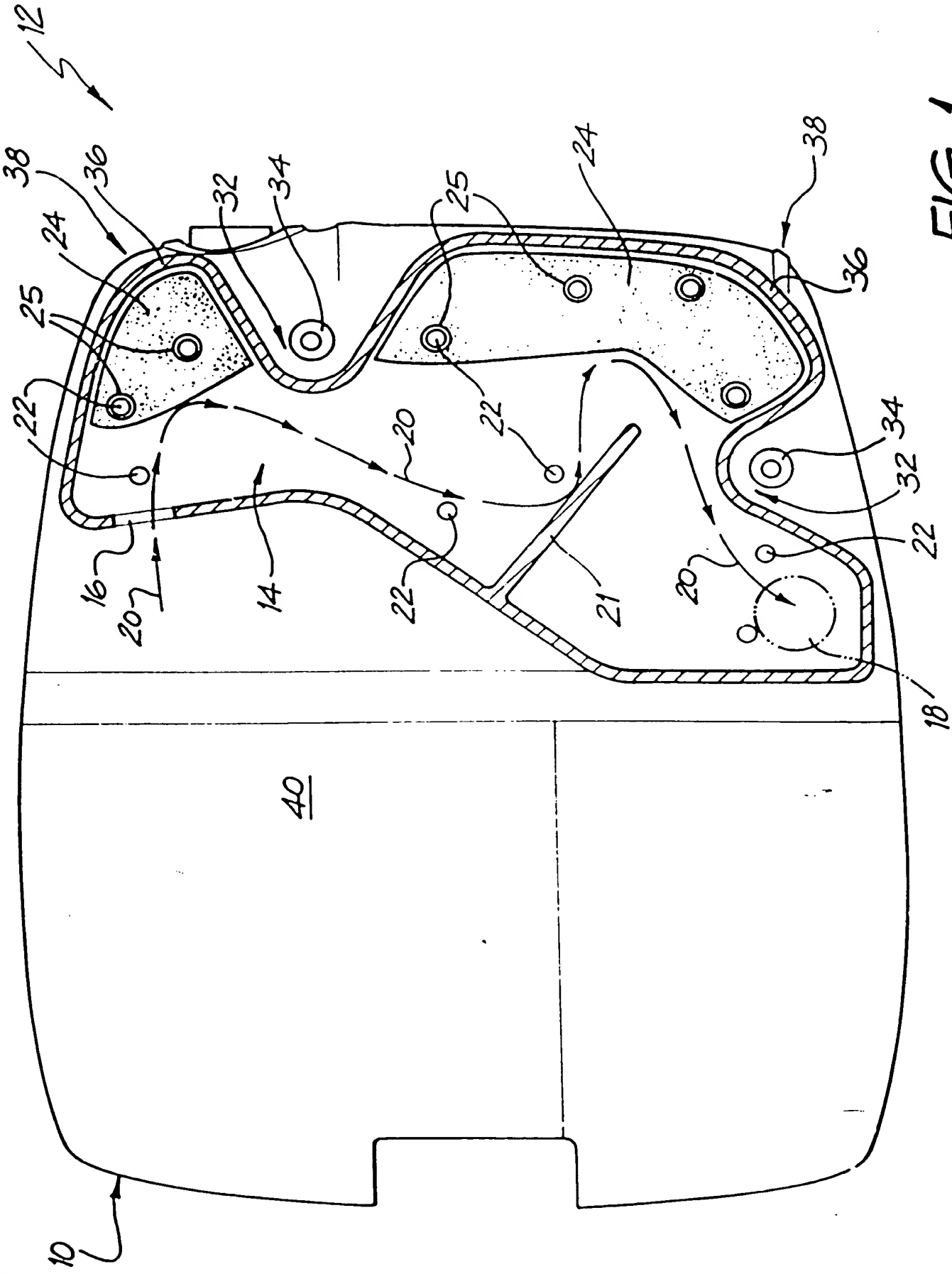
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FIG. 1

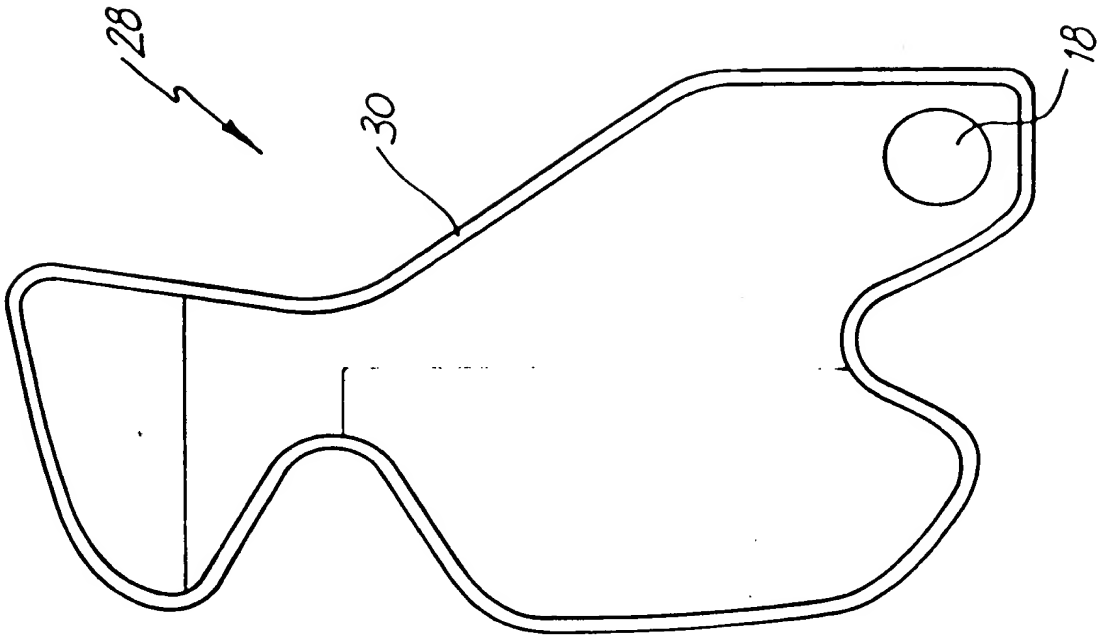

FIG. 3

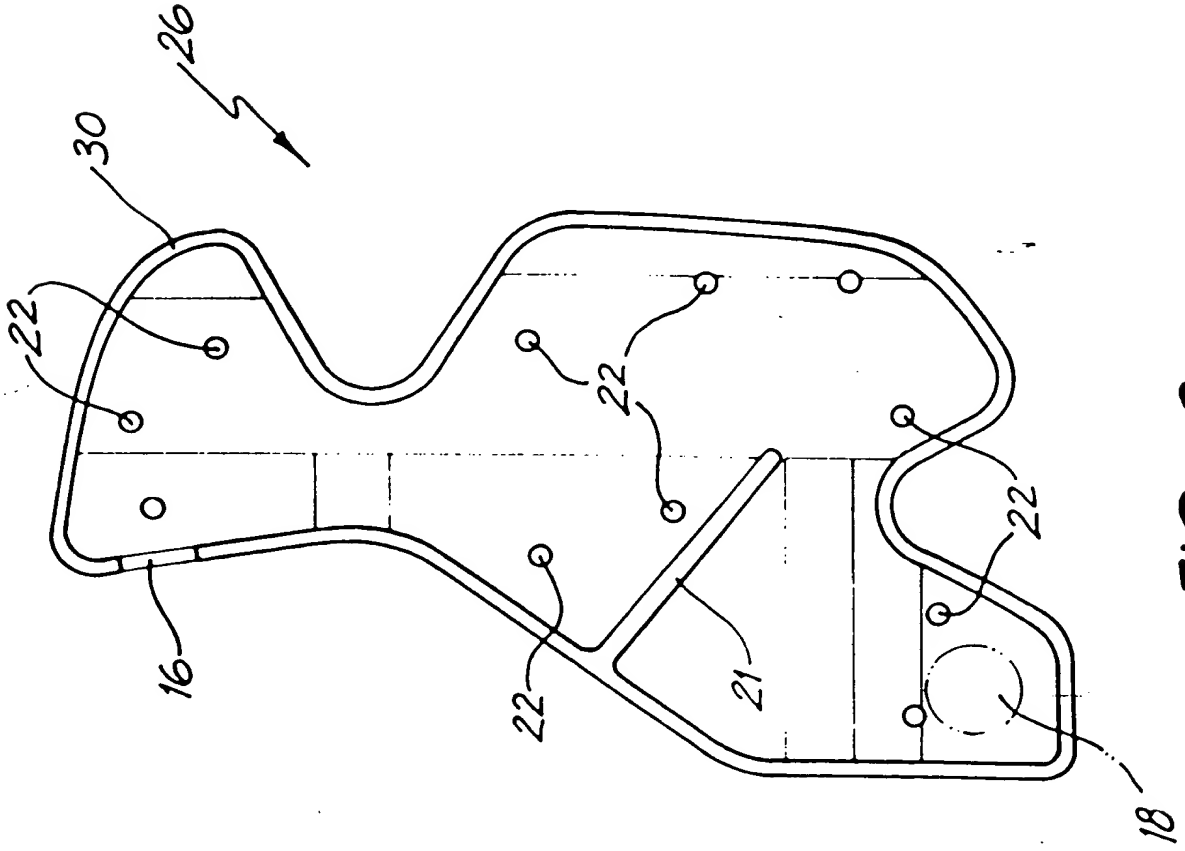

FIG. 2

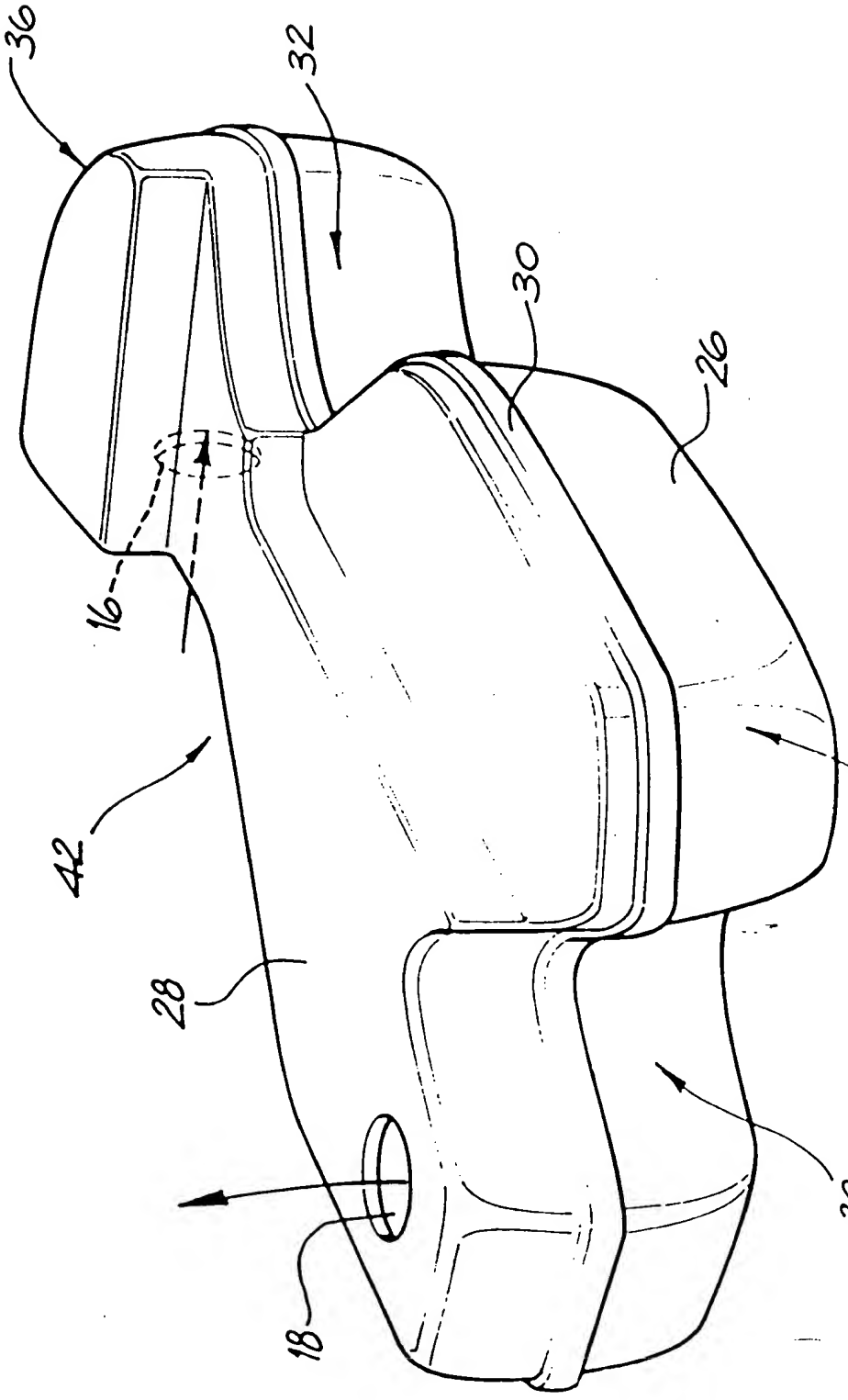

FIG. 4

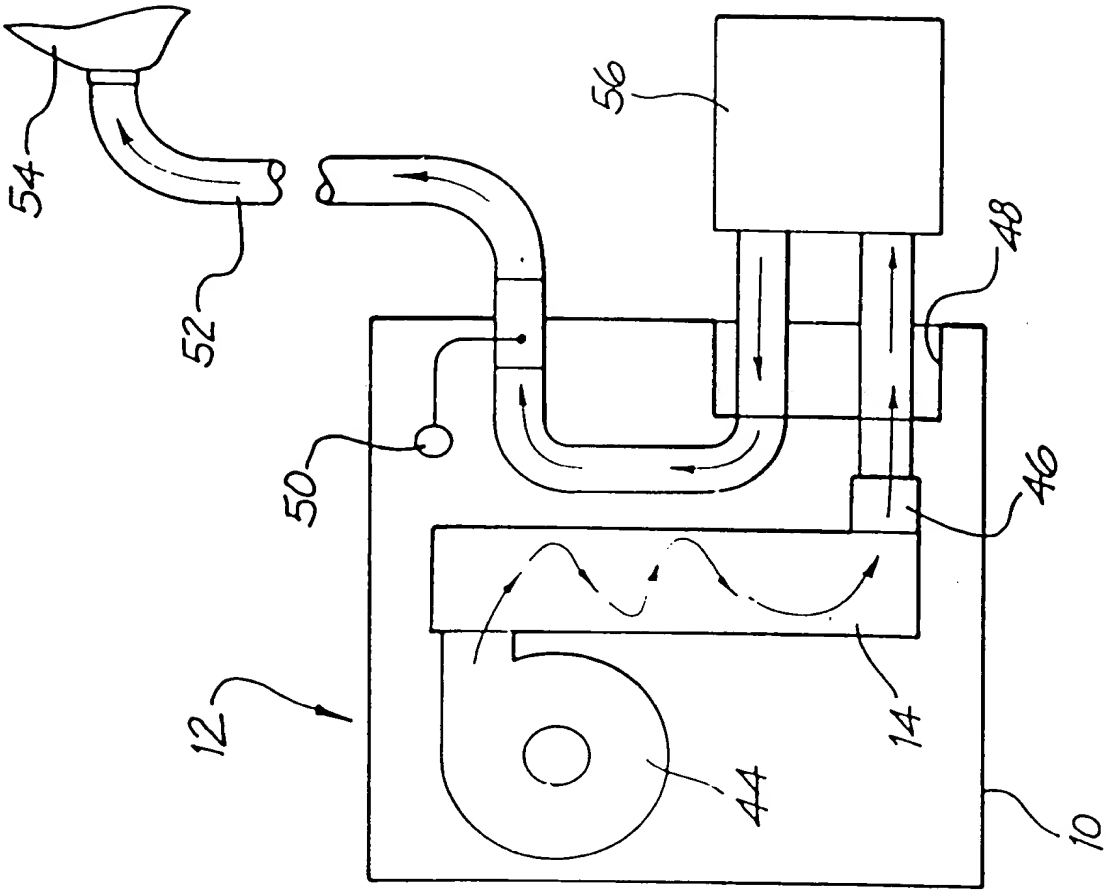

FIG. 6

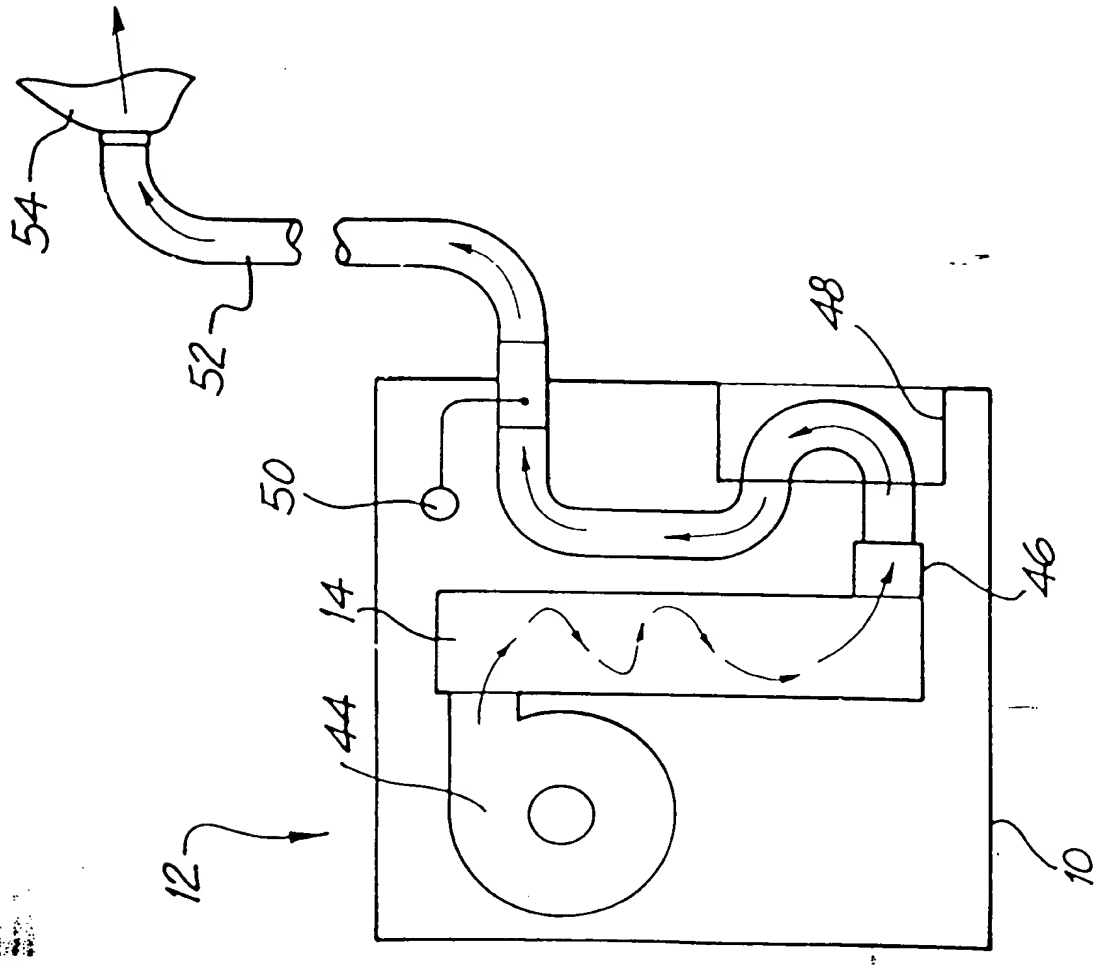

FIG. 5

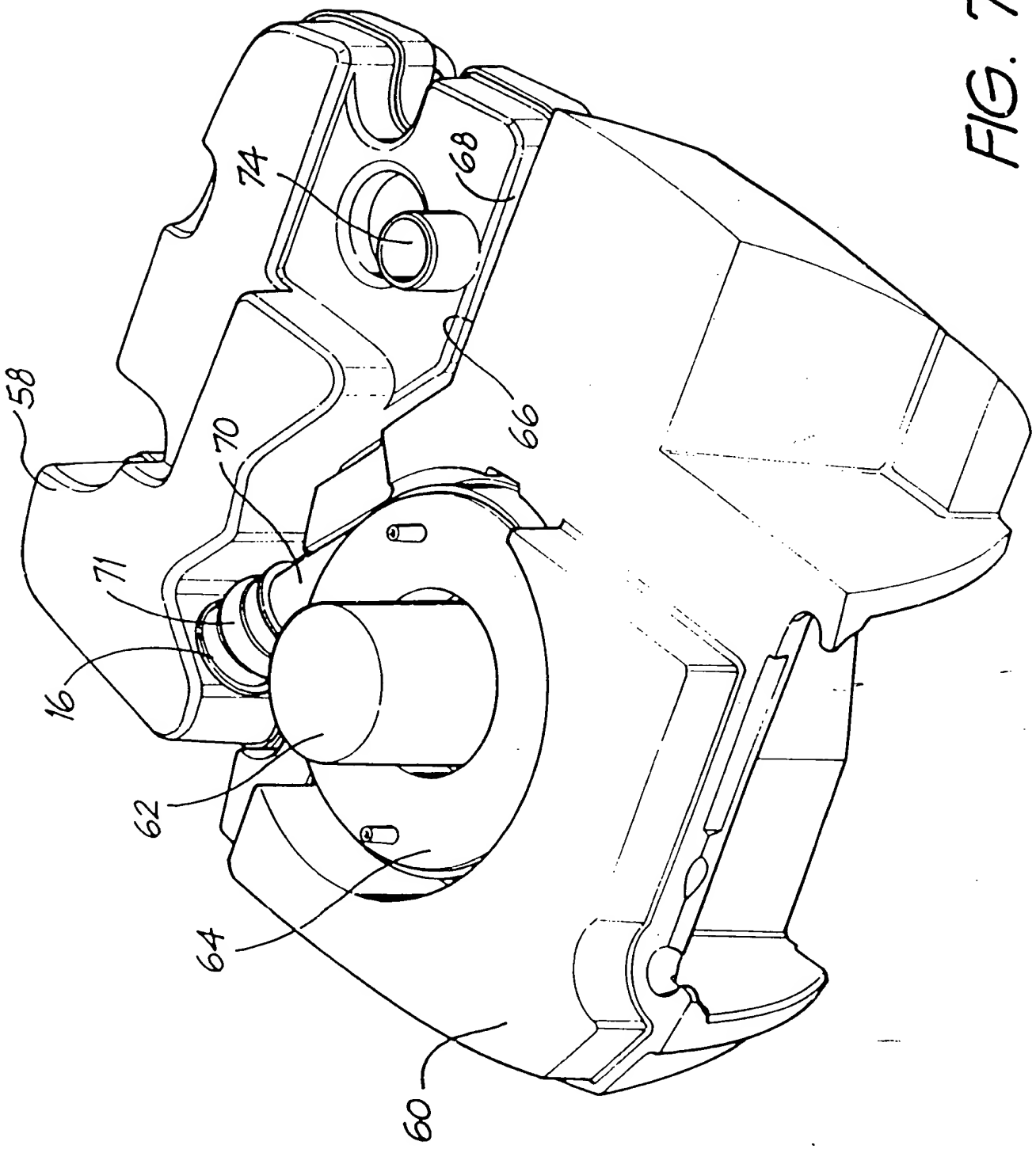

FIG. 7

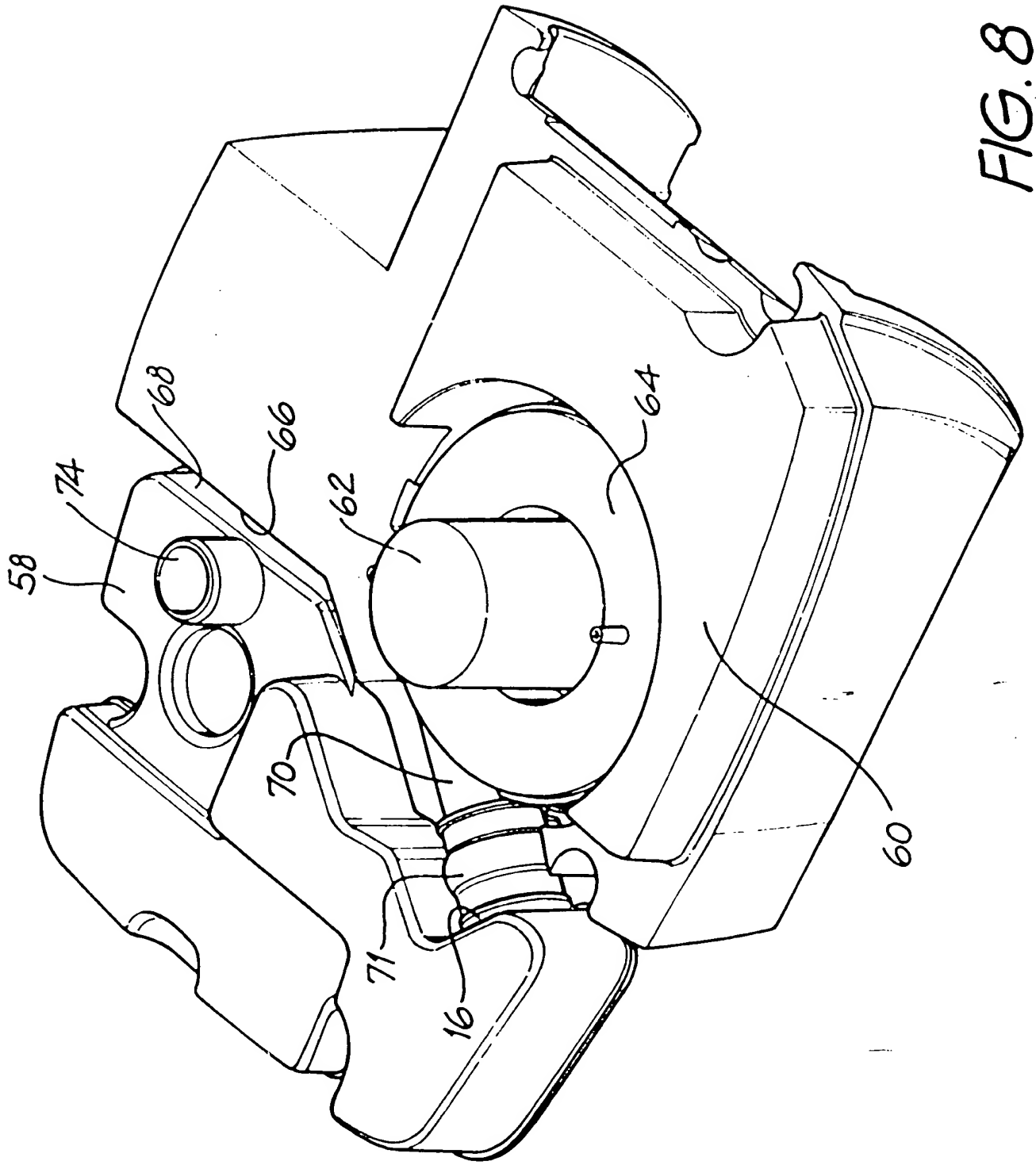

FIG. 8

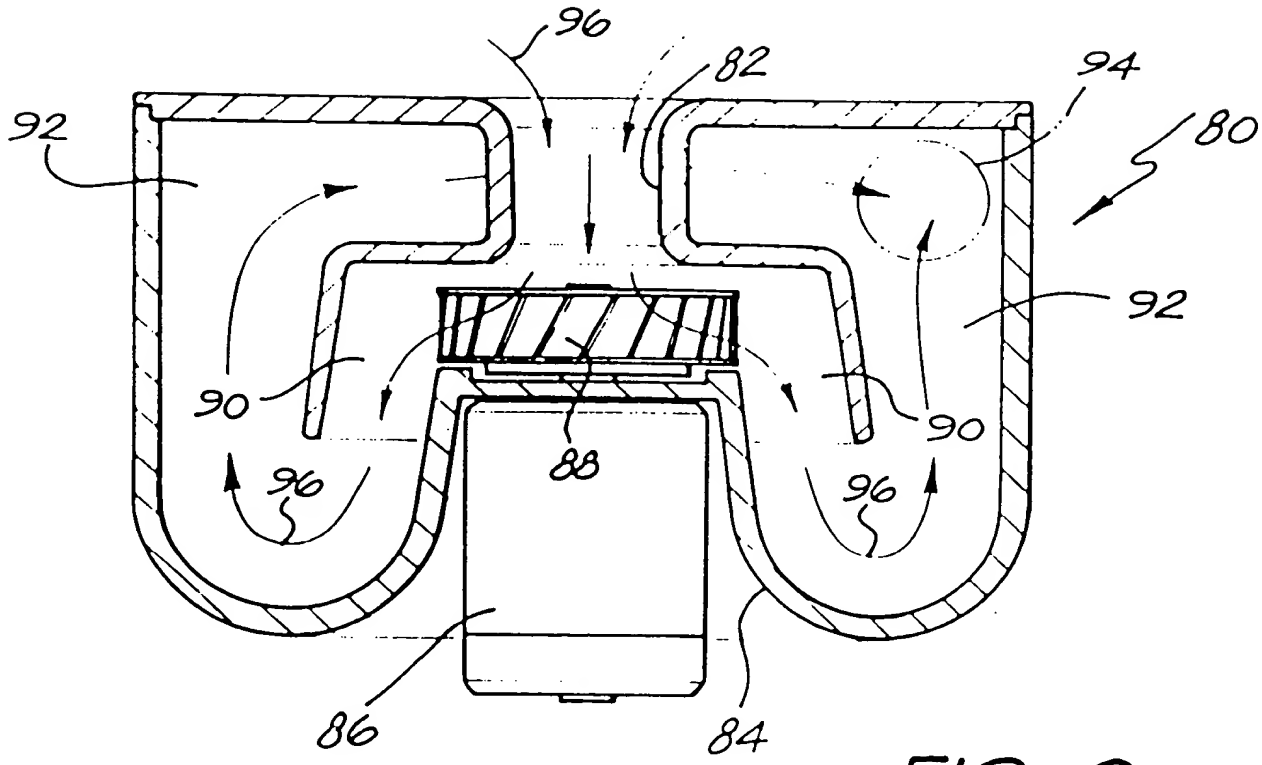

FIG. 9

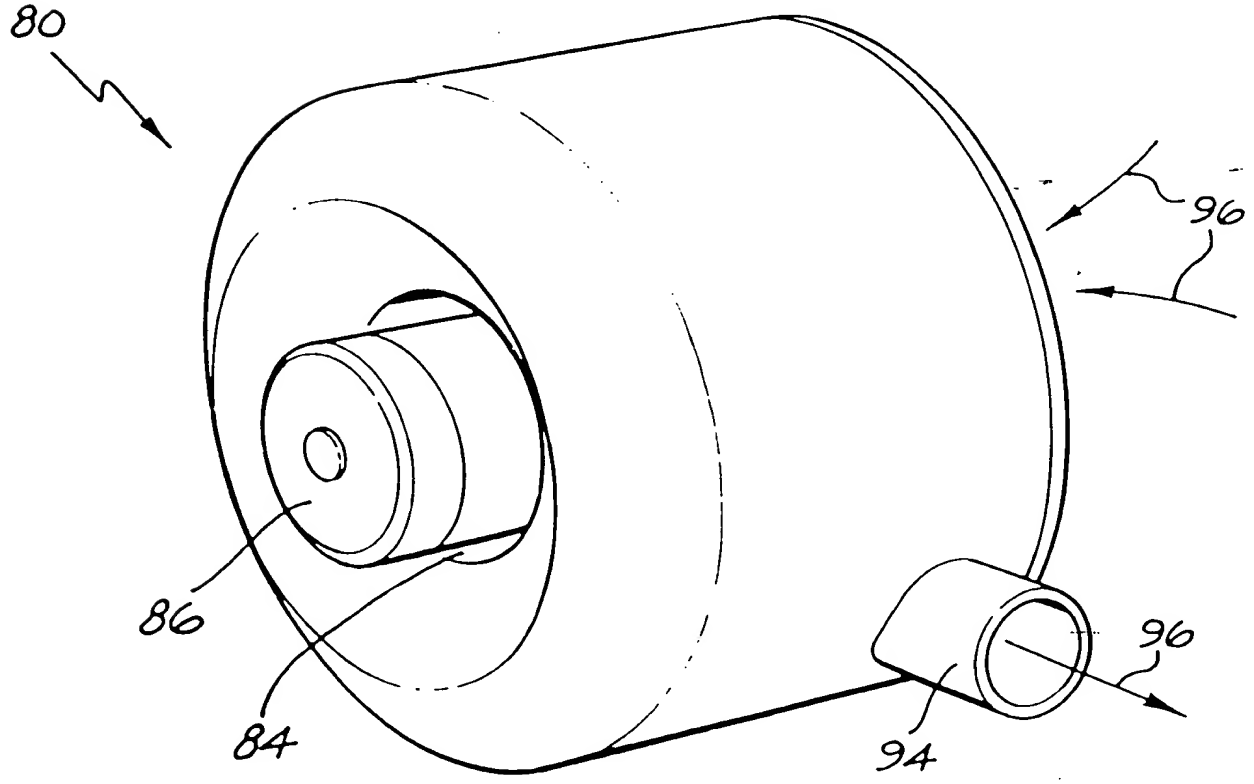

FIG. 10

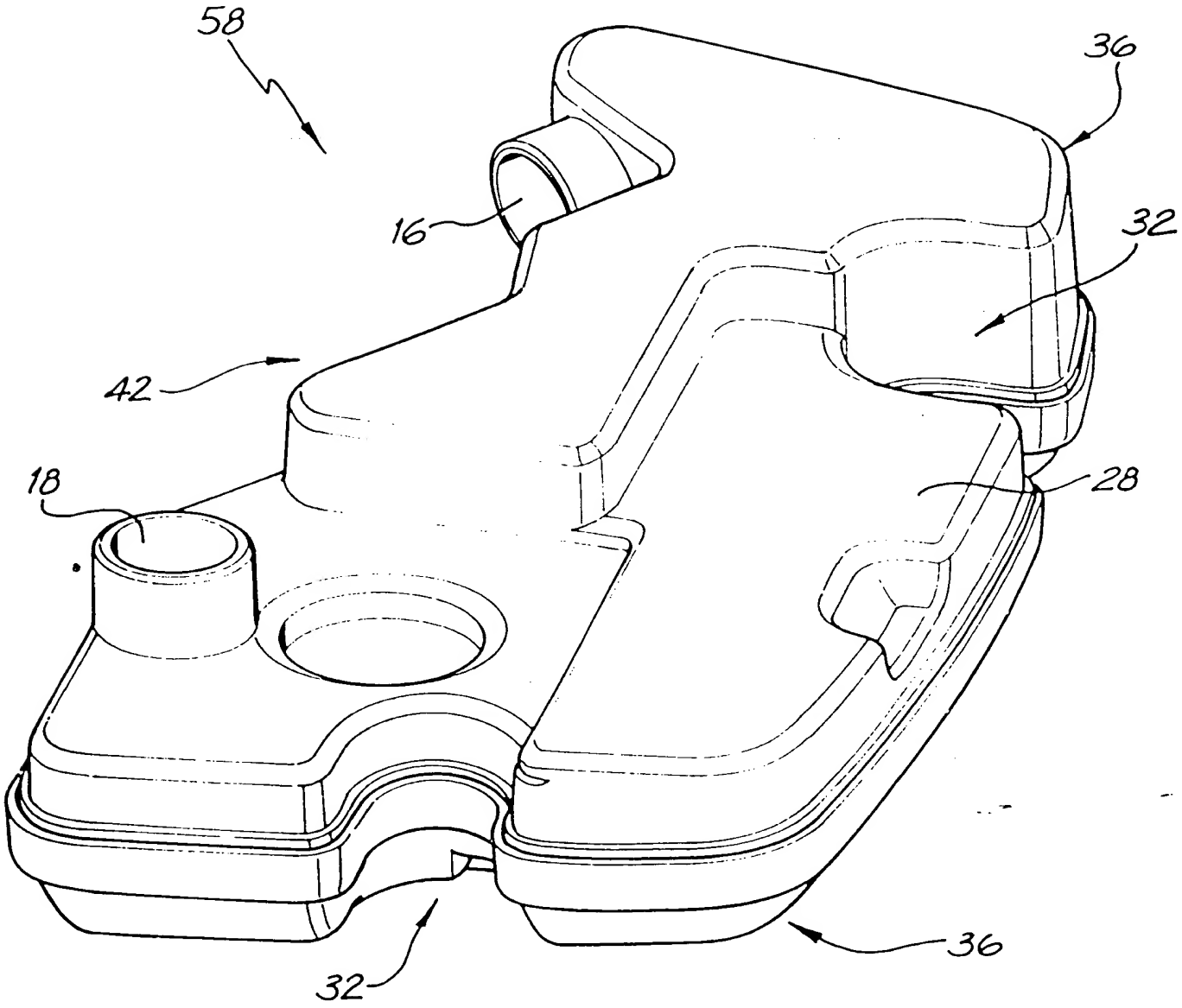

FIG. 11

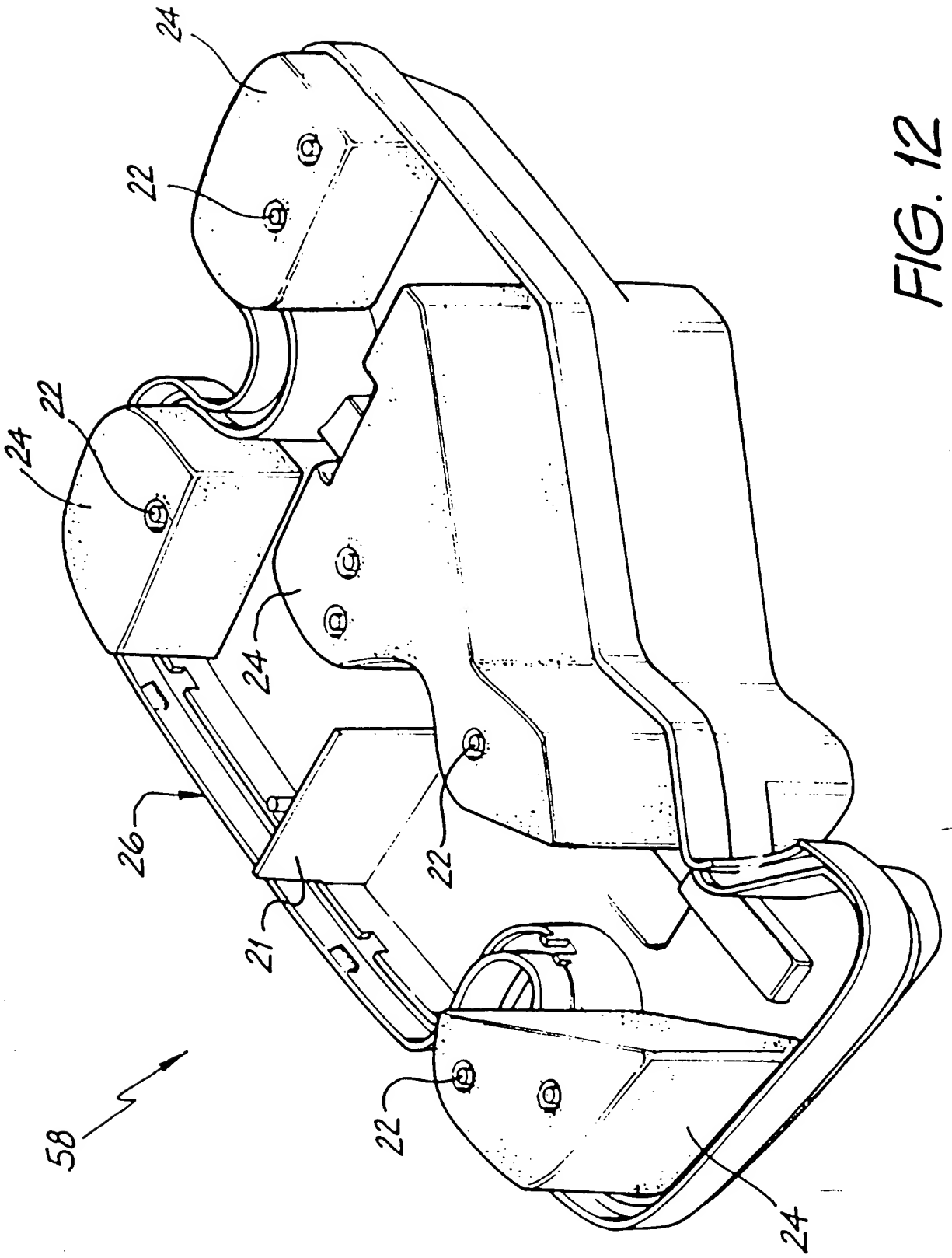

FIG. 12

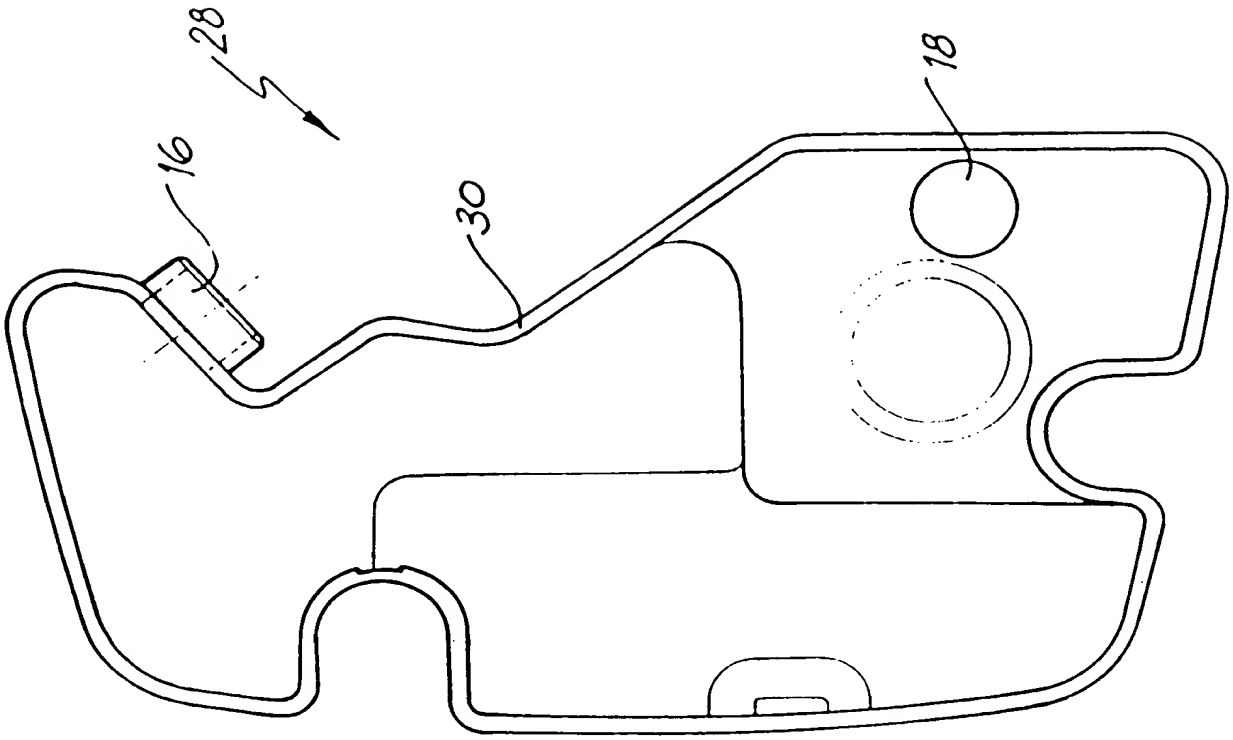

FIG. 14

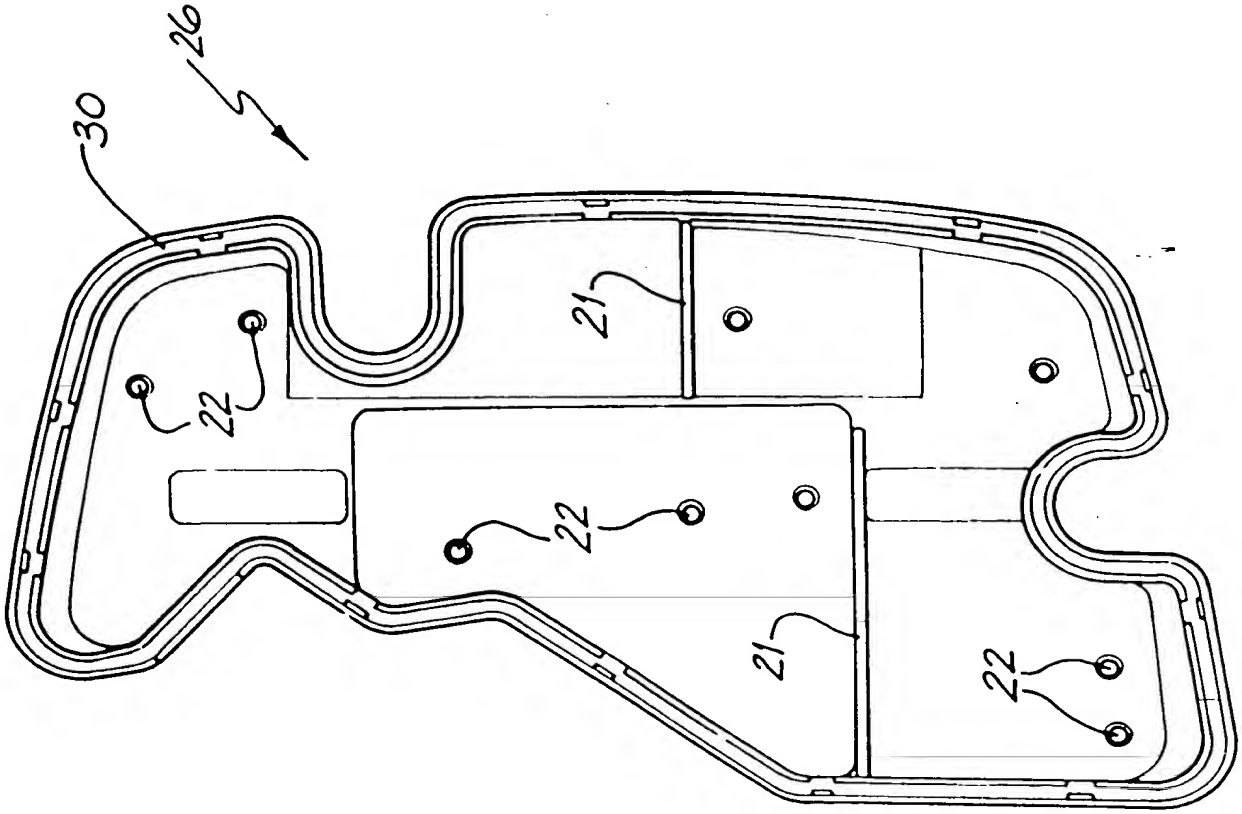

FIG. 13